DRIVERS AND BARRIERS TO PUBLIC SECTOR E-PROCUREMENT WITHIN NORTHERN IRELAND'S CONSTRUCTION INDUSTRY

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SUMMARY: *With the increasing use of the internet, E-Procurement and E-Tendering can offer viable alternatives to traditional paper-based processes. Despite the many benefits, and theorising about its pitfalls, little work has been carried out in the UK regarding the importance of the drivers and barriers related to this technology. This study examines the drivers and barriers for E-procurement in construction within Northern Ireland. Drivers and barriers have been ranked using a selection of 70 contractors who have expressed interest in tendering for Roads Service Northern Ireland (RSNI) contracts. RSNI is the agency in Northern Ireland responsible for roads and is one of the major construction clients. The results of this study have been compared with studies of a similar nature carried out in Australia and America in general goods and services e-procurement. Findings in this Northern Ireland study show that the two highest ranked drivers by the contractors were improving communication and reduced administration costs, while the two most important barriers were security of transactions and the uncertainty surrounding the legal issues of e-procurement. Therefore in Northern Ireland the results could be broadly categorised as costing and management issues for the main drivers while legal and technical issues are cited as the main barriers.*

KEYWORDS: *e-procurement, CITE, Construction, Drivers and Barriers.*

1. INTRODUCTION

The procurement process in construction has come under close scrutiny since the Egan report (Egan, 1998) pointed out that "*The UK construction industry can gain substantial improvements by delivering better service to clients, reducing construction cost, time and defects*". Previously, the Latham report (Latham, 1994) suggested as one of its proposals that savings in capital costs of 10% year on year could be achieved. E-Procurement will bring improvements to all aspects of the procurement process (National Institute of Governmental Purchasing, 2001, Minahan and Degan, 2001, McIntosh and Sloan, 2001, Ribeiro, 2001).

The procurement process is not solely the buying of goods and services but also incorporates buying strategy as well (Egbu et al, 2003). The public sector has produced a plethora of initiatives to investigate ways to improve the strategy and processes of procurement over the last 11 years. Despite these suggested advantages, Martin (2004) shows that in construction still less than 30% of tender documentation are sent out in electronic form. This is because construction procurement is more complex than general procurement. There are many different parties involved who feed information into the process – clients, consultants, contractors and suppliers. Construction work specifications can be less well defined with unknowns such as ground conditions having a

large impact on the overall cost. In contrast items in goods and services procurement can be tightly specified with little movement from the original specification. Factoring in risk is a major aspect and can determine the form of contract, how it is assessed and its overall outcome. For these reasons electronic solutions for general procurement need to be altered to meet the needs of construction procurement.

Knudsen (2003) suggests procurement can be condensed into the following six processes -"*e-sourcing, e-tendering, e-informing, e-mro (Maintenance, Repair and operating materials), ERP (Enterprise resource planning) and e-collaboration"*. The principle of electronic tendering is simply to provide a faultless system of transmitting input from the contractor's tender through to contract management removing the inefficiencies, delays and cost involved in manually processing tender information and re-transcribing for contract management activity. Bell (2001) suggests changes must take place if electronic solutions are to become predominant and companies are to remain competitive in the new era. This study identifies drivers and barriers to electronic procurement and analyses their effect and the uptake of e-tendering.

Previous studies have adequately described the numerous drivers and barriers for e-procurement in general procurement but no work has been published in the UK with regard to ranking drivers and barriers to construction procurement. Rankin et al (2006) published a study into drivers and barriers for e-procurement in Canada. This was the first piece of research to investigate drivers and barriers in construction e-procurement. This confirmed that the drivers and barriers identified from the goods and services industries could be applied to the construction industry. His study focussed more on e-sourcing within construction e-procurement rather than e-tendering.

With a stationary product and a production line that changes locations, greater complexity and economic value, the construction industry is essentially different to other industries. The consequence is that the drivers and barriers to construction e-procurement could be performing differently to those in the general goods and services industry. The Northern Ireland study is an attempt to test this hypothesis to either confirm it or reject it by testing the status of the construction industry, it uniqueness in terms of application of e-procurement.

2. METHODOLOGY

2.1 Summary of methodology

The research methodology followed can be summarised in the following seven stages:

1. Organisation identification
2. Sample identification
3. Identification of drivers and barriers to e-procurement through extensive literature review
4. Telephone briefing
5. Web-based survey
6. Ranking / scoring method
7. Presentation of results

These stages are described in detail in the following sub sections.

2.2 Organisation identification

Government departments in Northern Ireland established an "e-procurement Strategy Working Group" in 2003 in order to investigate and report on e-procurement strategy and solutions. The group is investigating all aspects of the procurement process from supplier registration to assessment of tenderers and contract management. Once solutions were identified a detailed public sector e-procurement strategy was drafted. Within the working group Roads Service Northern Ireland (RSNI), Water Service and the Northern Ireland Housing Executive (NIHE) were the organisations primarily concerned with construction procurement, while the others are concerned with general goods and services procurement. RSNI was selected as the case-study organisation for this study as it was one of the first government organisations to implement a system of electronic procurement in 2001.

RSNI is currently responsible for over 24,800 kilometres of public roads together with about 8,200 kilometres of footways, 6,000 bridges, 254,000 streetlights and 370 public car parks. Expenditure forecasts for the period 2005 - 2015 show that RSNI is due to spend more than the Water Service but less than NIHE (NIAO, 2005). The tendering system adopted by RSNI for procurement of construction works is shown in Fig. 1.

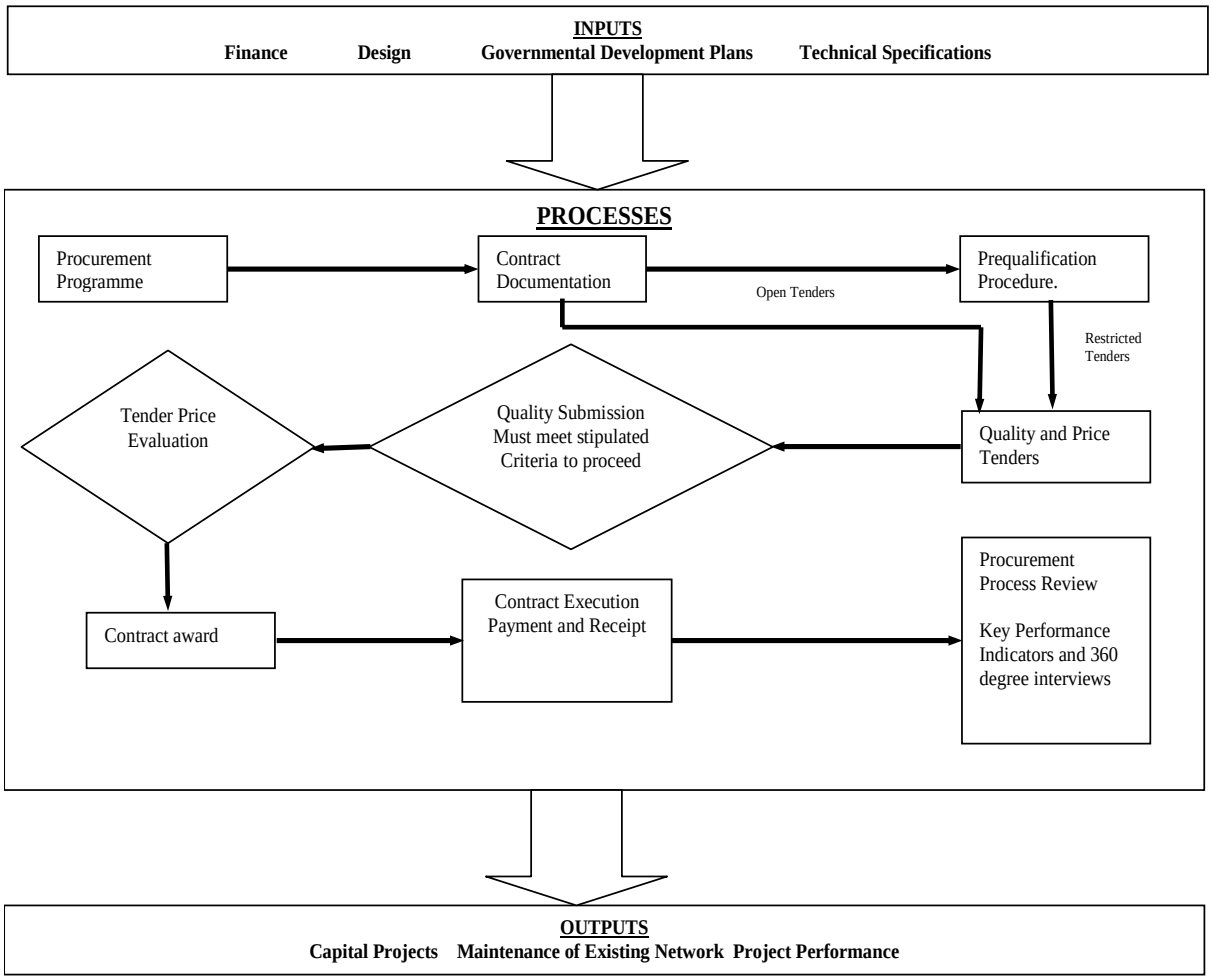

FIG. 1: The Roads Service Construction Procurement Process

The procurement process is a typical public sector procurement process used by many similar organisations in the EU (Panayiotou et al, 2004).

2.3 Sample identification

A list representing all 70 Contractors who had registered interest in or tendered for RSNI contracts over the past four years was obtained. This sample of 70 contractors, out of a total of 114 civil engineering contractors registered with the Construction Industry Training Board (CITB) in Northern Ireland was considered more appropriate than a random sample of Contractors within Northern Ireland as the contractors all had a similar focus reducing ambiguity of meaning (Naoum, 1995).

The sample by its nature included all sizes of companies. Fig. 2 shows a breakdown of respondents by company size based on the number of employees within the organisation.

Cosh (2005) in comparing Small Medium Enterprises (SME's) in Northern Ireland with the rest of the United Kingdom breaks down company size into three categories: micro employing 1-10, small employing between 10 and 100, and medium employing 100-500. The sample followed this breakdown but with most of the sample falling into the small category this was further sub-divided into three: 11-20, 21-50 and 51-100 to give greater clarification. The sample had 3.9% micro sized companies, 76.5% small sized companies and 19.6% medium sized companies.

For the purposes of this study drivers are defined as 'those processes or items which produce benefits through the implementation of an e-procurement solution'. Barriers are defined as 'those processes or items which restrict or prevent the implementation of an e-procurement system'.

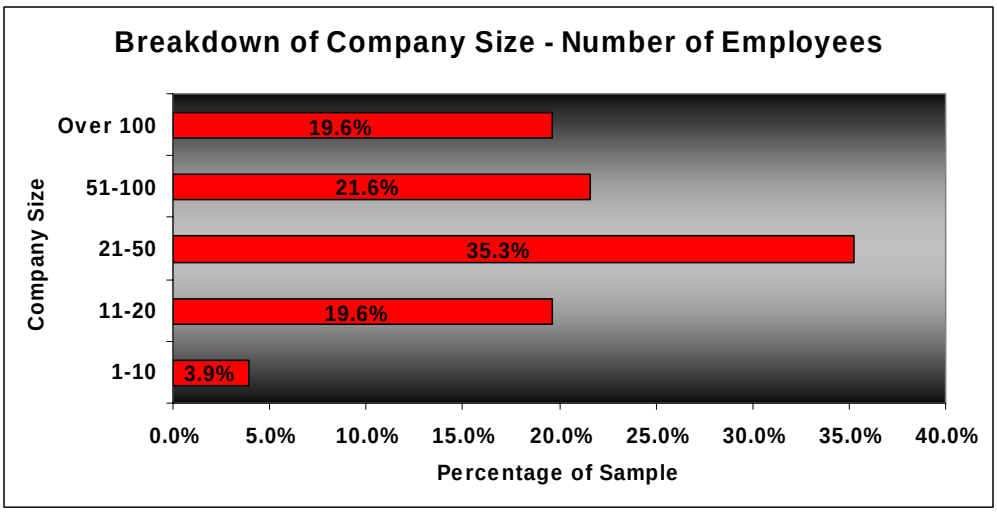

FIG. 1: Breakdown of Company size in the sample

A substantial literature review on e-procurement was carried out to identify relevant drivers and barriers to e-procurement. It further revealed that there were no studies reported on construction e-procurement that identifies drivers and barriers. Hence it was decided to use the drivers and barriers identified for general goods and services e-procurement as the basis for this study. These are identified and reviewed in detail in the section titled 'e-procurement'.

2.4 Identification of Drivers and Barriers to E-Procurement

Two systems of e-procurement were investigated. These were a fully web-based e-procurement system which utilised the internet and the CDR-based[1] system which RSNI had adopted. The CDR-based system distributes contract documents via a write once CDR. The completed documents are then submitted on a CDR with a handwritten signature on the front.

2.5 Telephone Briefing

A short telephone briefing was used to act as part of an initial contact pre-notification for a web-based survey. This was used to brief the respective respondents as to the aims and objectives of the survey and its format.

2.6 Web-based survey

PHP surveyor™ (a system similar to that described in Solomon (2001)) mounted on a website was used to conduct the survey in 2005. This software package provided the interface for the collection of responses. Data recorded through the interface is captured to a SQL query enabled database. The web-based interface allows direct entry of data by the respondents, this reduces common errors in data entry through the use of standard inputs. The web-based survey received 51 responses out of 70, representing 72.86% of the sample population, therefore surpassing the representativeness and bias levels for surveys (Eysenbach, 2004). PHP surveyor™ incorporates statistical analysis as part of the programme. However, this produces only basic statistics and the contents were exported to Microsoft Excel™ and SPSS for further analysis.

2.7 Ranking / scoring method

In order to allow comparison between studies this study was ranked in a similar way to Hawking et al (2004). This involved assessing the figures for the eight drivers and by giving those ranked 1 eight marks, 2 seven marks, 3 six marks and so on to obtain a numeric ranking. The eleven barriers were ranked in a similar manner, where rank 1 received eleven marks, rank 2 ten marks, rank 3 nine marks and so on obtaining the numeric ranking.

[1] CDR – Compact Disk Write once.

3. E-PROCUREMENT

E-procurement is the acquisition of goods and services without the use of paper processes (Przymus, 2003). Procurement activities can be grouped and defined in three different ways: indirect procurement, direct procurement and sourcing (Minahan and Degan, 2001). Indirect procurement involves selecting, buying and management of supplies for the day to day running of the company. Direct procurement may sometimes be called supply chain management and involves buying goods and organising activities to manufacture finished products. Sourcing can apply to both indirect and direct procurement and involves a four phase model (information, negotiation, settlement, and after-sales) (Kim and Shunk, 2003). Tendering involves the first three stages of this model. Electronic procurement / tendering is not a strategy in itself but the use of electronic means to carry out the procurement / tendering process (Minahan and Degan, 2001).

The buying process has considerably changed with the introduction of the internet and e-procurement removing lost time and errors resulting from the exchange of paper and retyping of data (Egbu et al, 2003). The forthcoming sub-sections review e-procurement from a worldwide, European, and UK perspective. Detailed studies on e-procurement in goods and services have been carried out in the United States and Australia. These countries are placed first and fourth respectively in a study that ranks countries on their uptake of e-procurement (Westcott, 2002). Their study further shows that Japan and Sweden occupy second and third place in the rankings, while the UK and Ireland are placed fifth and sixth respectively. See Table 1 below.

Table 1: Ranking of e-Procurement Usage by Country (Westcott, 2002)

Country	**E-Procurement Use Ranking**
United States	1
Japan	2
Sweden	3
Australia	4
United Kingdom	5
Ireland	6

3.1 The American Perspective

Forrester (2001 – 2003) of the Institute of Supply Management in the United States, quarterly assessed e-procurement between January 2001 and the third Quarter of 2003 by interviewing up to 700 of those involved in the purchase of goods and services. This has identified a number of benefits or drivers for e-procurement and maps the progress of usage within that country.

Others like Minahan & Degan (2001), based in Boston USA, carried out case studies, looking at goods and services procurement. The full list is given below (after Forrester (2001 – 2003) and Minahan & Degan (2001)):

- Cost savings
- Improved contract compliance
- Time savings
- Reduced administration costs
- Enhanced market data
- Improved responsiveness to changes in customer demand
- Improved collaboration / visibility with / of the supply chain
- Reduced operating and inventory costs
- On-Line negotiated cost reduction
- Increased accuracy of production capacity
- Enhanced “Skill sets” and standardised strategies.

However, neither of these studies ranked the benefits in any way. Davila et al (2003) was one of the first to rank six drivers in their study of US e-procurement. These, arranged in rank order with the most important first were; purchasing transaction costs, purchasing order fulfilment time, increased number of suppliers, purchasing cycle time, price paid for goods decrease and headcount to support purchase transactions. Barriers to e-procurement

were ranked in terms of risk. The barriers in relation to goods and services procurement were ranked as follows commencing with the greatest risk first: supplier relationships, technology and control, cost/benefit concern, organisational skill and lastly organisational culture. While the findings of these studies can generally be applied to e-procurement in construction, none have specifically assessed the situation in construction. Given the peculiar and complex nature of the construction industry and the extent of involvement of the supply chains there is a greater possibility that the effect of these drivers and barriers may differ. The identification of the effects of drivers and barriers to e-procurement in construction enables strategies for improvement to be developed.

3.2 The Australian Perspective

Hawking et al (2004) published work on general e-procurement in Australia. They ranked the following drivers in order of importance as: price reduction in tendering, negotiated unit cost reduction, improved visibility of customer demand, reduced administration costs, improved market intelligence, reduced operational and inventory costs, enhanced decision making, improved contract compliance, shortened procurement cycle times, improved visibility of supply chain management, increased accuracy of production capacity, and enhanced inventory management.

Hawking et al (2004) further investigated the barriers to e-procurement in Australia identifying and ranking these in order of importance as: inadequate technical infrastructure, lack of skilled personnel, inadequate technological infrastructure of business partners, lack of integration with business partners, implementation costs, company culture, inadequate business processes to support e-procurement, regulatory and legal controls, security, co-operation of business partners, inadequate e-procurement solutions and upper management support.

In a similar manner to the American studies, the Australian work gives an insight into what the drivers and barriers to e-procurement in construction might be but no construction specific studies exist there either.

3.3 The European and UK Perspective

Westcott and Mayer (2002) show the linkage between European and UK legislation with regard to e-procurement in construction. The paper quotes two small undergraduate studies which show uptake of e-tendering at 24% and 15% of their respective populations. Westcott and Mayer while referring to drivers and barriers, do not rank them in any way. No work has been published in the UK with regard to ranking drivers and barriers to e-procurement in construction.

4. THE DRIVERS FOR E-PROCUREMENT IN CONSTRUCTION

The identification of the drivers to e-procurement in construction is paramount to achieving relevance in any study. The drivers below have been identified from other published works in goods and services procurement and can be used to allow comparison to take place between the results of this study in Northern Ireland and the results obtained in Australia.

4.1 Driver summary

The following drivers for e-procurement were selected for ranking in this study:

1. Price reduction in tendering
2. Reduction in time to source materials
3. Reduced administration costs
4. Reduced staffing levels in procurement
5. Gaining competitive advantage
6. Improving communication
7. Enhanced decision making and market intelligence
8. Reduced operating and inventory costs

These drivers are explained in depth in the following sections.

4.1.1 Driver 1 – Price reduction in tendering

According to empirical studies carried out in the United States of America, the two most important measures for the success of procurement processes are cost and time (Gebauer et al, 1988). A survey in the USA in 2001 resulted in 75% of respondents citing reduction in costs (National Institute of Governmental Purchasing 2001).

Hawking et al 2004 put this figure at between 75 and 80% in Australia. Cost reduction has also been highlighted in the UK (Erridge et al (2001)) and in China (Kong et al 2001). Rankin (2006) shows that this driver is also applicable to e-procurement in the construction industry.

4.1.2 Driver 2 – Reduction in time to source materials

In a survey in the USA 85% of the respondents indicated that they achieved time savings through E-Procurement (National Institute of Governmental Purchasing 2001). Product sellers identified other drivers related to sourcing materials such as emphasis on time to market, product quality-based competition, customer uncertainty and the need to improve bottom line costs (Kalakota, Tapscott & Robinson 2001).

Reduction in time has been proved as a relevant driver by Knudsen (2003) in Sweden, who says "*E-procurement is a rapid efficient method of finding and connecting new sources, being a lean channel for communication*". Further comments by McIntosh & Sloan 2001 and Ribeiro 2001 in USA and UK respectively, state that industry wide adoption of e-procurement initiatives could significantly add to streamlining material procurement processes and bring speed, flexibility, efficiency and increased profit margins to organisations. Rankin (2006) shows a reduction in the complete procurement cycle time as a result of e-procurement implementation. Panayiotou et al (2004) state that "*E-Procurement solutions make corporate purchasing activities more efficient and cost effective*". Time reduction was therefore considered to be an important driver that needs to be ranked in this study.

4.1.3 Driver 3 – Lower Administration costs

One way of assessing whether administration costs have fallen is through the examination of profits that do not induce competition, known as rents. Knudsen carried out a study in 2003 which showed that Ricardian rents (efficiency savings) could be increased by adopting E-procurement initiatives. However, his work did not rank the efficiency savings identified against other benefits of e-procurement. This study is therefore adding to knowledge by assessing lower administration costs against the other drivers. Rankin(2006) shows that reduction in paperwork and therefore lower administration costs ranked second highest driver for e-procurement in construction in Canada.

4.1.4 Driver 4 – Reduction in procurement staff

Egbu et al 2003 showed that through implementation of an e-procurement system, a steel supplier was able to carry out a multi-million pound project with only 20% of the staff the company would normally have used. Reduction in staff is an important way of producing competitive advantage through reduced costs. The fourth driver this paper investigated was reduction in procurement staff as a spin-off from implementing e-procurement.

4.1.5 Driver 5 – Gaining competitive advantage

Increased profitability of a company will result in an advantage being gained over its competitors. One way of achieving this is by centralising functions such as payroll, procurement and logistics in a single country (NOIE 2000) as electronic systems of procurement do not have geographical and time barriers. Kalakota (2001) states adoption of e-procurement "*allows procurement activities 24 hours a day, 7 days a week, 365 days a year*". As a centralised department can oversee all procurement activities and different offices worldwide can access the same documentation when required, this gives a distinct advantage over the much slower process of having to post documentation between offices. This extends the supply chain beyond geographical boundaries to a much wider group. This raises other logistical considerations which may impact on scheme quality. This improvement in competitiveness is further highlighted by Wong and Sloan (2003) in that, gaining competitive advantage, reducing procurement costs, and increased profitability are seen as some the most important perceived benefits of e-procurement. Rankin (2006) shows that e-procurement results in increased productivity and greater market access.

4.1.6 Driver 6 – Improving communication

Hawking et al (2004) examined three separate drivers viz.: "Improving visibility in supply chain management", "Improving visibility in customer demand" and "Increased compliance". Rankin (2006) also identifies data transaction accuracy as a driver. These are all associated with "Improving Communication". Since e-procurement allows sections of electronic documentation to flow through the supply chain, it improves the speed of returns and subcontractor price visibility. As it is easier to communicate requirements in a quicker more accessible manner, it will result in a better understanding of requirements and due compliance. It also allows

clients to gauge the state of the market by seeing how much interest is shown in the tender. For the purposes of this study these three drivers have been combined and considered under the broad category of improving communication.

4.1.7 Driver 7 – Improved market intelligence and enhanced decision making

Hawking et al, 2004 considered market intelligence and the decisions made on that intelligence as two separate drivers. However, as reliable procurement decisions cannot be made without market intelligence and each is reliant on the other for the purpose of this study these two are considered together as "Improved Market Intelligence and Enhanced Decision making".

4.1.8 Driver 8 – Reduced Operating and Inventory costs

The last driver assessed through the survey was "Reduced Operating and Inventory Costs". As the study chose Roads Service as a case study and surveyed its contactors it was important to see if this served as a driver in the civil engineering sector.

4.2 Other Drivers

Hawking et al (2004) also measured enhanced inventory management, increased accuracy of production capacity and negotiated unit cost reduction. These may be of interest in goods and services procurement but are of less importance in construction procurement.

The RSNI study gave an opportunity for participating contractor's to identify any additional drivers that they deemed important. The results show that none of the respondents identified the three drivers above as being important, confirming the decision to disregard them.

5. THE BARRIERS TO E-PROCUREMENT

Despite the proven benefits of using electronic means in procurement, in a UK wide study, Wong and Sloan (2004) showed that only 48% of respondents indicated that they were able to conduct e-commerce effectively. This indicates that there are barriers to the implementation of e-procurement.

5.1 Summary of Barriers

The complete list of barriers ranked by this study was:

1. Unsure as to the legal position of e-procurement
2. Company culture
3. Upper management support
4. Do not have the IT infrastructure
5. IT systems too costly
6. Lack of technical expertise
7. Lack of e-procurement knowledge / skilled personnel
8. Lack of business relationship with suppliers providing e-procurement
9. Security of transactions
10. Interoperability concerns
11. No business benefit realised

5.1.1 Barrier 1 – unsure as to the legal position of e-procurement

The Wong and Sloan (2004) study further showed that ICT is improving communication in construction. On the negative side it also showed that only 26% of respondents agreed that ICT was acceptable as admissible written proof during construction. Only 17% thought that it was acceptable as a written notice. This questions the legal validity of electronic information exchange and must be considered as a barrier to the implementation of an e-procurement system. Price Waterhouse Coopers (2002) was the first to identify this barrier while Hawking et al (2004) used it as a barrier to e-procurement in their survey. However their study does not specifically relate to construction.

In the European Union, Julia-Barcelo (1999) concludes that legal difficulties is one of the main barriers to e-procurement. Difficulties highlighted by Julia-Barcelo were: lack of specific legal regulation, different national

approaches, and validity, enforceability and/or evidentiary problems. In America, similar sentiments were expressed by Pena-Mora and Choudary (2001).

5.1.2 Barriers 2 and 3 – Company culture and upper management support

According to Carayannis et al (2005) traditional public procurement faces many deficiencies. They enumerated these as complicated procedures and extended relationships, excessive state intervention, bureaucratic dysfunctionalities, absence of a clear national IT policy, large volume of paper, lack of flexible centralised control, lack of information quality and resistance to change. With the exception of a reduction in paper in public procurement each of the above remain as barriers to implementation of a system of e-procurement. It is pointed out that "resistance to change" is one of the biggest barriers to the introduction of e-procurement within the public sector. Resistance to change, lack of a widely accepted solution and lack of leadership, which are cultural issues, are highlighted as barriers by Davila et al (2003) in the USA. These produce a slowdown in adoption of e-procurement and result in a failure to reap many of the perceived benefits. Therefore a cultural change needs to take place prior to adoption of an e-procurement system. In order to bring this about, champions need to be appointed with full senior management support. However, with the pressures on companies, other competing initiatives have taken priority in many occasions. A study in Singapore by Kheng et al (2002) showed that this was the largest barrier in that country with 60% of the respondents under the impression that other initiatives were of more importance than e-procurement. This points towards the need for cultural change brought about by senior management support if e-procurement is to be successfully implemented.

5.1.3 Barriers 4, 5 and 6 – Do not have the IT infrastructure, It systems too costly and lack of technical expertise

These three distinct barriers are linked to IT. The first is that the company does not have the technology to carry out e-procurement (Wong and Sloan 2004). The second is that it cannot afford IT (Hawking et al 2004) and the last is that they cannot operate IT (Hawking et al, 2004, Davila et al, 2003). Rankin (2006) shows that all three of these should be considered as barriers in the construction industry.

5.1.4 Barriers 7 and 8 – Lack of e-procurement knowledge / skilled personnel and lack of a business relationship with suppliers capable of e-procurement

These barriers are related to personnel issues such as an older generation that has not kept up to the advances in IT related issues relying heavily on traditional forms and means of procurement. Price Waterhouse Coopers (2002) defend this view by stating "*We don't have enough 'Internet human' resources, and can't hire people*." As experience counts in pricing documents this has lead to a difficulty for many contracting firms. Hawking et al (2004) identified the lack of business relationships with suppliers showing the need for an e-procurement enabled supply chain as another barrier for the implementation of e-procurement. Rankin (2006) shows that in Canada this barrier is ranked as second highest.

5.1.5 Barrier 9 – Security of transactions

Security is a major concern when working on the internet. Jennings (2001) states "*The World Wide Web leaks like a sieve. Data transmitted on it can be garbled, can reassemble wrongly at the other end, or can display only partially because of incompatible software"*. Many of the banks although acknowledging these problems, have set systems into place to mitigate these problems. An example is the Bank for International Settlements (BIS) who state that their security "*should include establishing appropriate authorisation privileges and authentication measures, logical and physical access controls, adequate infrastructure security to maintain appropriate boundaries and restrictions on both internal and external user activities and data integrity of transactions, records and information"*. Rankin (2006) shows that this is one of the technical issues with e-procurement still to be fully overcome. Despite having security measures in place and the banking institutions are satisfied with the level of security this affords, this study shows that this is one of the largest barriers to e-procurement uptake.

5.1.6 Barrier 10 – Interoperability concerns

Providing procurement information over the internet produces interoperability concerns. This is due to the fact that software companies have sought to make their product unique. In doing so, they have endeavoured to stop migration of data between systems. In order to overcome this difficulty CITE (Construction Industry Trading Electronically) was initiated. However, it can be seen from Martin (2004) that less than 30% of the construction industry has used CITE prescribed systems. Rankin (2006) further shows that compatibility, interfacing with other systems and stability, are technical issues which have become barriers to e-procurement implementation.

5.1.7 Barrier 11 – No Business benefit Realised

Egbu et al (2004) investigated the cost/benefit concern – where the expenses outweigh the benefits of moving to electronic procurement. This study investigated this under the title “no business benefit realised”.

In a similar manner to the drivers, contractors were asked to identify any barriers that they had not been asked to rank. Again no additional barriers were identified by the respondents.

6. DRIVERS TO E-PROCUREMENT IN NORTHERN IRELAND

This section examines web-based systems of e-procurement and the results are contrasted against those from a CDR-based system utilised by RSNI (the case study). The following graphs (Fig. 3 and Table 1) show how Contractors within Northern Ireland ranked the drivers for e-procurement mentioned above. The results are then added to give an overall ranking for e-procurement.

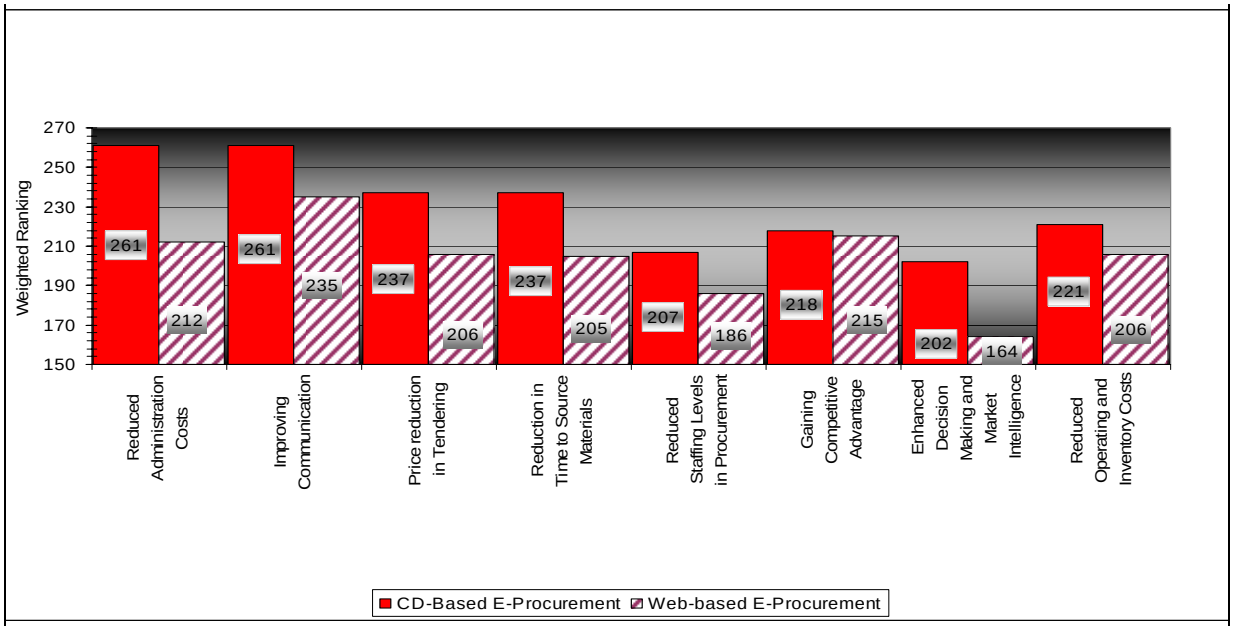

FIG. 2: Drivers for Electronic Procurement

In Fig. 3 the rankings given to the drivers for e-procurement for both CD-based and web-based e-procurement. The figure shows that ‘Reduced Administration Costs’ is the highest ranked driver for both methods.

Table 2 indicates the rankings given to the drivers for e-procurement for both CD-based and web-based e-procurement and combines these to show the overall rankings for e-procurement.

TABLE 1: Table showing ranked Drivers for E-Procurement

Driver	Rank CDR-based e-Procurement	Rank Web-based e-Procurement	Overall Rank e-Procurement
Improving Communication	1	1	1
Reduced Administration Costs	1	3	2
Price reduction in Tendering	3	4	3
Gaining Competitive Advantage	6	2	4
Reduction in time to Source Materials	3	6	5
Reduced Operating and Inventory Costs	5	4	5
Reduced Staffing Levels in Procurement	7	7	6
Enhanced Decision Making and Market Intelligence	8	8	7

7. ANALYSIS OF DRIVERS IN RELATION TO E-PROCUREMENT

The ranking performance of the drivers to e-procurement are analysed in detail in this section using Fig. 3 and Table 2 provided in the preceding section.

Table 3 below shows a comparison of the ranked drivers with the results of the drivers ranked in the Australian study as described in the analyses below.

TABLE 2: Table showing Comparisons with Australian Study

Driver	Northern Ireland e-Procurement Rank	Australian e-Procurement Rank Hawking et al (2004)
Improving Communication In Australian Study (Customer Demand CD and Supply Chain Management SCM, Improved Compliance IC)	1	CD 3 SCM 10 IC 8
Reduced Administration Costs	2	4
Price reduction in Tendering	3	1
Gaining Competitive Advantage	4	N/A
Reduction in time to Source Materials	5	9
Reduced Operating and Inventory Costs	5	6
Reduced Staffing Levels in Procurement	6	N/A
Enhanced Decision Making (EDM) and Market Intelligence(MI)	7	EDM 7 MI 5
Negotiated Unit Cost Reduction	N/A	2
Enhanced Inventory Management	N/A	12
Increased Accuracy of Production Capacity	N/A	11

The discussion below compares the ranking performance of the drivers to e-procurement identified in the Australian study of general goods and services e-procurement carried out by Hawking et al (2004).

7.1 Improved Communication

Table 1 and Table 2 show that in Northern Ireland both CDR-based e-procurement and Web-based e-procurement rank 'Improved Communication' as the highest driver. 'Improved Communication' is a combination of three drivers in the Australian study and although comparing favourably with 'Improved Visibility of customer demand', it differs substantially from the Australian study with regard to 'Improved Visibility of Supply Chain Management' where it ranks tenth out of twelve drivers and 'Improved compliance' which is ranked eighth out of twelve drivers. This could be due to the fact that poor communication or the non-collaborative nature of participants is a greater problem in the Construction industry.

7.2 Reduced Administration Costs

'Reduced administration costs' is ranked second overall (joint first in CDR-based e-procurement and third for Web-based e-procurement), corresponding well to the Australian study, (Hawking et al, 2004), where it is ranked fourth. Cost savings due to the introduction of E-Procurement are well documented. Mukhopadhyay et al (1995) reported on Chrysler Corporation, Choudhury (1998) examined the aircraft parts industry, Anderson Consulting (2000) reported on Cisco, Chevron and Eastman Chemicals. In the construction industry Davila et al (2003) state "*Companies that use e-procurement technologies report savings of 42 per cent in purchasing transaction costs"*. However, Tonkin (2003) states that "*There are very few studies that systematically evaluate the actual cost and benefit movements associated with the various forms of e-procurement in the public sector and there are even fewer of these published*".

Eadie (2003) reported on the e-procurement related savings within RSNI, indicating savings of £5210 for one off schemes based on four tenderers and £9545 for a typical term contract with 7 tenderers in four divisions. The repetitive costs of reproduction are minimised by using the CD system. This report showed that by the introduction of an e-tendering system the costs in producing documents for one-off contracts could be reduced to 4.7% of the original cost and 2.6% of the cost for a typical term contract. This would support the findings of a case study in Water Service Northern Ireland published by CITE (2001) showing a total cost saving of 90% by

electronic documentation over a paper version of the same contract. This is substantially more than the 36% of original cost reported by Woking Borough Council (2003).

The e-procurement process used by RSNI simplifies and considerably reduces time for tender evaluation. Eadie (2003) in his report showed that based on the savings in time taken to enter figures for tender evaluation and the consequent checking process, cost savings up to £25,000 per contract could be achieved. The extent of the savings is determined by the number of tenderers and the size of the Schedule of Rates and prices/Bill of Quantities. Some of the Schedules of Rates and Prices in RSNI contracts contain over 2500 items. Typing these for assessment is laborious. To complete procedures two persons must then check the data for typing errors. Hence, electronic assessment of prices results in large savings in time and therefore costs. Drivers ranked 3 and 4 overall are linked.

7.3 Price Reduction in Tendering

Although ranked third in CDR-based e-procurement and fourth in web-based e-procurement in both systems, the actual system of tendering does not produce as much savings as the administrative costs surrounding those systems. The contractors recognised the savings and this was reflected in the ranking. In comparison, this was ranked highest in the Australian study.

7.4 Gaining Competitive Advantage

The Contractors who are most efficient in operating electronic systems will gain competitive advantage. The results show that contractors do not see the current RSNI system as giving them a competitive advantage in the marketplace. The contractors ranked the CDR-based system sixth out of eight due to all of them having to use the same system. However, when a new web-based tendering system was suggested, the ability to operate this system was seen as a way to excel over the competition and 'gaining competitive advantage' and the ranking rose to second place. This was not ranked in the Australian study.

8. BARRIERS TO E-PROCUREMENT IN NORTHERN IRELAND

The results of the barriers study are presented in a similar way to those for the drivers in order to compare the rankings. This produced the following results:

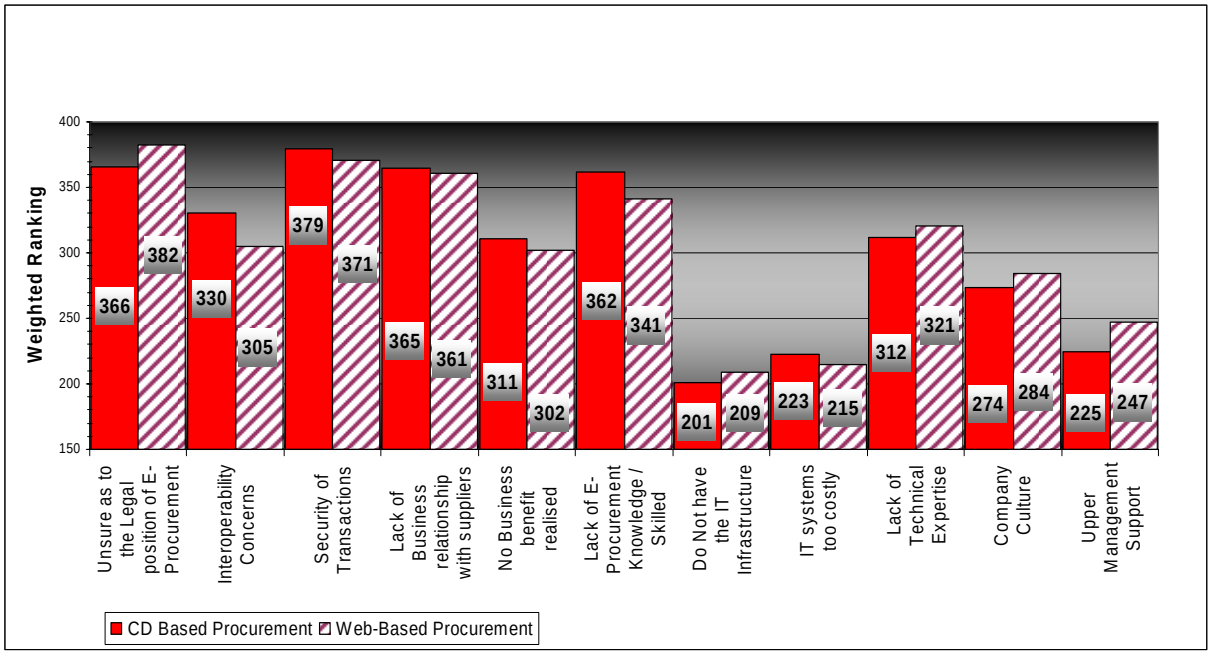

FIG. 3: Ranking Barriers to E-Procurement

In Fig. 4 the rankings given to the barriers for e-procurement for both CD-based and web-based e-procurement. The figure shows that 'Security of Transactions' and 'Unsure as to the legal position of e-procurement' are the two highest ranked drivers.

TABLE 3: Table showing Ranked Barriers to E-Procurement

Barrier	Rank CDR-based e-Procurement	Rank Web-based e-Procurement	Overall Rank e-Procurement
Security of Transactions	1	2	1
Unsure as to the legal position of e-procurement	2	1	1
Lack of a business relationship with suppliers providing e-tendering	3	3	3
Lack of e-procurement knowledge/Skilled Personnel	4	4	4
Interoperability Concerns	5	6	5
Lack of Technical Expertise	6	5	5
No business benefit realised	7	7	7
Company Culture	8	8	8
Upper Management Support	9	9	9
IT systems too costly	10	10	10
Do not have the IT infrastructure	11	11	11

Table 4 indicates the rankings given to the barriers for e-procurement for both CD-based and web-based e-procurement and combines these to show the overall rankings for e-procurement.

9. ANALYSIS OF BARRIERS IN RELATION TO E-PROCUREMENT

The ranking performance of the barriers to e-procurement are analysed in detail in this section using Fig. 4 and Table 4 provided in the preceding section.

Table 5 below shows the comparison of the ranked barriers with the results of the barriers ranked in the Australian study as described in the analyses above.

TABLE 4: Table showing Comparisons with Australian study

Barrier	Northern Ireland e-Procurement Rank	Australian e-Procurement Rank Hawking et al (2004)
Security of Transactions	1	9
Unsure as to the legal position of e-procurement	1	8
Lack of a business relationship with suppliers providing e-tendering. In Australian study this is broken into 3 – Inadequate Technical Infrastructure of Business Partners (ITIBP) and Lack of Integration with Business Partners (LIBP) Cooperation of Business Partners (CBP)	3	ITIBP 3 LIBP 4 CBP 10
Lack of e-procurement knowledge (LK) /Skilled Personnel (SP)	4	LK N/A SP 2
Interoperability Concerns	5	N/A
Lack of Technical Expertise	5	7
No business benefit realised	7	11
Company Culture	8	6
Upper Management Support	9	12
IT systems too costly	10	5
Do not have the IT infrastructure	11	1

The discussion below compares the ranking performance of the barriers to e-procurement identified in the Australian study of general goods and services e-procurement carried out by Hawking et al (2004).

9.1 Security of Transactions

'Security of Transactions' was ranked in first place in this study. Kheng et al (2002) found a similar situation in Singapore thus confirming the findings of this research. They state "*in 1999, 59% of companies that were interested in adopting e-commerce cited security as the key barrier*". However it is different from the situation in Australia where security comes ninth in the list of barriers.

The RSNI CDR-based system is an attempt to address the security concerns through physical means. A CDR only allows writing once of the relevant documents which cannot then be changed. The labels are printed directly on to the face of the CDR and the handwritten signature on the label cannot be changed by the client (RSNI) thus providing security. In the client's opinion this is as secure as the paper system that preceded it. The only way to alter the submitted documents would be by replacement CD making it much harder to alter than the paper system.

The Internet based systems have issues here, Julia-Barcelo (1999) raises concerns over confidentiality on the use of the internet. The CD system provides the client greater degree of confidentiality in that the contract documents are still provided within a sealed envelope hidden from the public view in the same way as paper documents and thus confidentiality is preserved. A fully internet based system will have to use security systems such as encryption to preserve confidentiality. This should allay the fears expressed by Pena-Mora and Choudary (2001) over documentation being tampered with.

It is suggested that on this evidence that the security aspects of the tender submission are catered for in the CD system. However, moving from this system to a fully electronic one would open the security debate further and bring the difficulties with authentication and security into play. Further work needs to be carried out into how these could be mitigated.

9.2 Legal Issues

The legal issues involved were identified as the top most barrier for web-based e-procurement and second for CDR-based e-procurement. This again differed from Australia where the legal controls were only ranked eighth. The state of Legal issues will become clearer once case law is in place in the UK with regard to status of electronic documents. RSNI attempts to mitigate adverse effects by retaining paper copies in order to create enforceable contracts. CITE also condone the parallel use of paper copies and states on its web site "*Companies that receive an unpriced BoQ in the CITE format are expected to return the priced bill in the same format. However, it is accepted that for commercial reasons, it may be decided to exchange a printed copy as well*".

Further difficulties regarding the confidentiality and enforceability of a fully Internet solution utilising e-mailed tenders were identified by Jennings (2001). This article shows the system of e-mailing tenders of values under £250,000 (i.e. smaller tenders) is fraught with problems and insecurity, leaves opportunity for fraud and legal loopholes, making the contracts let in this manner open to repudiation.

Jennings (2001) after discussion on the Electronic Communications Act states that "*the position, therefore, remains that there are certain, limited, types of transaction that cannot happen electronically if they are to be enforceable*". The RSNI system, which uses a write once CD-R backed up by a paper copy, has sought to address this issue. Fully web-based systems will need to be tested in court and case law built up before this barrier is completely overcome.

9.3 Lack of a Business Relationship with Suppliers

Lack of a business relationship with suppliers was ranked third overall. The Australian study also ranks this as the third highest barrier to E-Procurement regarding the infrastructure of those they did business with. As E-Procurement becomes more popular it will filter down the supply chain as more of the construction industry become e-procurement literate. It is hoped that with UK government focusing on electronic initiatives such as Achieving Excellence and Modernising Government, that the supplier base will increase over the next few years thus negating the effect of this barrier.

9.4 Lack of E-Procurement Knowledge / Skilled Personnel

In a similar way to the previous barrier this barrier, Lack of E-Procurement Knowledge / Skilled Personnel, will fade as Contractors get used to the e-procurement systems in place. In order to tender for RSNI work contractors needed to have a quality management system in place or show that they are working towards implementing one

within a year of contract award. For any ISO accredited firm training is compulsory and should be implemented. This should cover e-procurement and therefore mitigate the effects of this barrier.

9.5 Interoperability Concerns

'Interoperability concerns' was the barrier ranked fifth by the Contractors for the CDR-based system and sixth for web-based systems. The RSNI CDR-based system by using the industry standard spreadsheet (Microsoft Excel™) has sought to address 'Interoperability Concerns'. A macro can be written by any Contractor who so desired to export the results to a Construction Industry Trading Electronically (CITE) approved package. Most systems are now compatible with Excel™ and those that are not can usually handle CSV (Comma Separated Variable) files that can be created by Excel™. Freeware software is also supplied on the CDR to allow all the documents to be opened. The unavailability of a comparable fully web-based system has resulted in a drop in rank from fifth to sixth for web-based e-procurement. This barrier was not ranked in the Australian study.

9.6 No Business Benefit Realised

This barrier was ranked sixth in Northern Ireland. It shows that many contractors are not aware of the huge benefits that e-procurement has brought to their organisations. Educating the construction contractors on the benefits of implementing an e-procurement system can negate this barrier. Australian buyers have realised the many benefits from e-procurement and have ranked it eleventh. Constructing Excellence website (2006) has published a number of case studies in the UK in the past showing benefits to contractors.

9.7 Other Barriers to e-procurement

At the other lowest end of the ranking table 'The cost of IT systems' is ranked tenth and 'Do not have the IT infrastructure' ranked eleventh. This shows that most Northern Ireland contractors feel that they have the necessary equipment to carry out e-procurement and that the cost of IT is not a problem. This is in contrast to the Australian situation where more bespoke systems are used pushing the cost up and requiring high end systems to function. This has resulted in 'IT cost' being ranked fifth and 'not having the IT infrastructure' being the biggest barrier in Australia.

10. CONCLUSIONS

It is important that any system introduced in the Public Sector should focus on the identified drivers in order to gain favour with those that use it. A system which improves communication and reduces the price of tendering (the two highest ranked drivers), will gain approval with the contractors who would use an e-procurement system. In a similar manner to the drivers, any system in place should avoid the highest ranked barriers or seek to alleviate their impact. Security of transactions and the legal position with regard to E-Procurement were determined as the chief barriers in the Northern Ireland study.

In Northern Ireland costing and management issues lead on the positive (driver) side with issues such as legal and security fears dominating the negative (barrier) side. This is similar to the situation in Australia (Hawking et al, 2004). 'Lack of skilled personnel' in responsible positions in Northern Ireland seemed to have a greater impact on the uptake of e-procurement. In a country which has 57% more computer graduates per head of population than the US and 25% more than the rest of the UK, Northern Ireland has a greater potential to successfully overcome these barriers and make the most of the drivers to e-procurement.

The findings of the Northern Ireland study show that although similar drivers and barriers are graded, the ranking for e-procurement in construction is very different than that for general e-procurement. The findings for the highest ranked drivers and barriers bear this out with the highest ranked construction drivers and barriers ranked very much lower in general than goods and services e-procurement. This confirms the initial assertion of this study and confirms the need for more detailed and broader studies in this area specific for the construction industry.

Further research is needed to develop strategies to enhance the drivers and eliminate barriers to e-procurement in the UK. This will require a methodology to map and benchmark the drivers and barriers to e-procurement for a construction organisation and develop strategies to improve the status of e-procurement for the organisation concerned. The next stage of this research aims to expand the classification of drivers and barriers to the whole of UK and develop a methodology to analyse the e-readiness of construction organisations as a precursor for the development of a strategy of e-procurement (Perera et al, 2006).

Continuous developments in information technology systems and an increased globalisation of the construction industry, requires greater and more efficient methods of collaboration between stakeholders of a construction project. E-procurement provides the foundation and strategy for improved collaboration throughout the project lifecycle. This research, particularly focusing on the construction industry and its status of e-procurement, identified and ranked the most important drivers and barriers to construction e-procurement, which can lead the way in developing further strategies for e-procurement in construction.

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